

What is claimed is

- 1        1. A method of test generation for testing computer  
2        software, comprising the steps of:  
3                modeling a software application as a finite state ma-  
4                chine to define a behavioral model;  
5                associating said behavioral model with a focus, said  
6                focus having a reference to said behavioral model, and  
7                having at least one directive; and  
8                generating a test program according to state transi-  
9                tions of said behavioral model and said directive of said  
10              focus.
  
- 1        2. The method according to claim 1, wherein said di-  
2        rective comprises a model independent directive.
  
- 1        3. The method according to claim 1, wherein said di-  
2        rective comprises a model dependent directive, and a cov-  
3        erage variable of said behavioral model is tagged by a  
4        tag of said model dependent directive, said coverage  
5        variable having allowable values.
  
- 1        4. The method according to claim 3, wherein said di-  
2        rective further comprises a model independent directive.
  
- 1        5. The method according to claim 3, wherein said test  
2        program references said coverage variable, and said step

3 of generating is performed until said coverage variable  
4 has assumed each of said allowable values.

1 6. The method according to claim 5, wherein said cov-  
2 erage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until a  
4 cross product of said coverage variables has assumed all  
5 possible values thereof.

1 7. The method according to claim 5, wherein said cov-  
2 erage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until an  
4 orthogonal array of said coverage variables has assumed  
5 all possible values thereof.

1 8. The method according to claim 3, wherein said  
2 model dependent directive comprises a plurality of model  
3 dependent directives, and said coverage variable is  
4 tagged by a plurality of tags of said model dependent di-  
5 rectives.

1 9. The method according to claim 3, wherein said tag  
2 is a number-of-tests-per-value tag.

1 10. The method according to claim 3, wherein said  
2 model dependent directive is a mask-value directive.

1       11. The method according to claim 1, wherein said di-  
2       rective comprises a plurality of directives that are com-  
3       bined to define a directive expression, wherein said step  
4       of generating is performed until said directive expres-  
5       sion has a predetermined value.

1       12. The method according to claim 1, wherein said  
2       step of modeling is performed by retrieving said behav-  
3       ioral model from a model archive.

1       13. The method according to claim 1, wherein said  
2       step of associating is performed by retrieving said focus  
3       from a focus archive.

1       14. The method according to claim 13, further com-  
2       prising the steps of comparing state variables of foci of  
3       said focus archive with state variables of said behav-  
4       ioral model; and

5       responsive to comparisons resulting from said step of  
6       comparing revising selected ones of said foci.

1       15. A computer software product, comprising a com-  
2       puter-readable medium in which computer program instruc-  
3       tions are stored, which instructions, when read by a com-  
4       puter, cause the computer to execute a method of test  
5       generation for testing computer software, the method com-  
6       prising the steps of:

7       accepting as a first input a behavioral model of a  
8 software application, wherein said behavioral model com-  
9 prises a finite state machine;

10      accepting as a second input a focus having a refer-  
11 ence to said behavioral model, and having at least one  
12 directive;

13      associating said behavioral model with said focus;  
14 and

15      generating a test program according to state transi-  
16 tions of said behavioral model and said directive of said  
17 focus.

1       16. The computer software product according to  
2 claim 15, wherein said directive comprises a model inde-  
3 pendent directive.

1       17. The computer software product according to claim  
2 15, wherein said directive comprises a model dependent  
3 directive, and a coverage variable of said behavioral  
4 model is tagged by a tag of said model dependent direc-  
5 tive, said coverage variable having allowable values.

1       18. The computer software product according to  
2 claim 17, wherein said directive further comprises a  
3 model independent directive.

1       19. The computer software product according to  
2 claim 17, wherein said test program references said cov-

3       verage variable, and said step of generating is performed  
4       until said coverage variable has assumed each of said al-  
5       lowable values.

1       20. The computer software product according to  
2       claim 19, wherein said coverage variable comprises a plu-  
3       rality of coverage variables, and said step of generating  
4       is performed until a cross product of said coverage vari-  
5       ables has assumed all possible values thereof.

1       21. The computer software product according to  
2       claim 19, wherein said coverage variable comprises a plu-  
3       rality of coverage variables, and said step of generating  
4       is performed until an orthogonal array of said coverage  
5       variables has assumed all possible values thereof.

1       22. The computer software product according to  
2       claim 17, wherein said model dependent directive com-  
3       prises a plurality of model dependent directives, and  
4       said coverage variable is tagged by a plurality of tags  
5       of said model dependent directives.

1       23. The computer software product according to  
2       claim 17, wherein said tag is a number-of-tests-per-value  
3       tag.

1       24. The computer software product according to  
2 claim 17, wherein said model dependent directive is a  
3 mask-value directive.

1       25. The computer software product according to  
2 claim 15, wherein said directive comprises a plurality of  
3 directives that are combined to define a directive ex-  
4 pression, wherein said step of generating is performed  
5 until said directive expression has a predetermined  
6 value.

1       26. The computer software product according to  
2 claim 15, wherein said step of modeling is performed by  
3 retrieving said behavioral model from a model archive.

1       27. The computer software product according to  
2 claim 15, wherein said step of associating is performed  
3 by retrieving said focus from a focus archive.

1       28. The computer software product according to  
2 claim 27, further comprising the steps of comparing state  
3 variables of foci of said focus archive with state vari-  
4 ables of said behavioral model; and  
5            responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1       29. A method of test generation for testing computer  
2 software, comprising the steps of:

3       modeling a software application as a finite state ma-  
4 chine to define a behavioral model;

5       associating said behavioral model with a focus, said  
6 focus having a reference to said behavioral model, and  
7 having at least one directive;

8       deriving an abstract test suite from said behavioral  
9 model and said focus, wherein said abstract test suite  
10 complies with a test constraint that is encoded in said  
11 focus;

12       executing said abstract test suite in an execution  
13 engine.

1       30. The method according to claim 29, wherein said  
2 step of executing said abstract test suite comprises the  
3 step of generating a test script from said abstract test  
4 suite; wherein said test script is executed in said exe-  
5 cution engine.

1       31. The method according to claim 29, wherein said  
2 step of producing said abstract test suite is performed  
3 with a testing interface.

1       32. The method according to claim 31, wherein said  
2 testing interface comprises an abstract-to-concrete  
3 translation table.

1       33. The method according to claim 29, wherein said  
2 testing interface comprises a test driver, having an op-  
3 erator interface, and further comprising the step of:

4           varying parameters of said test driver via said op-  
5 erator interface in accordance with requirements of said  
6 software application.

1       34. The method according to claim 29, wherein said  
2 directive comprises a model independent directive.

1       35. The method according to claim 38 wherein said  
2 coverage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until a  
4 cross product of said coverage variables has assumed all  
5 possible values thereof.

1       36. The method according to claim 38, wherein said  
2 coverage variable comprises a plurality of coverage vari-  
3 ables, and said step of generating is performed until an  
4 orthogonal array of said coverage variables has assumed  
5 all possible values thereof.

1       37. The method according to claim 29, wherein said  
2 directive comprises a model dependent directive, and a  
3 coverage variable of said behavioral model is tagged by a  
4 tag of said model dependent directive, said coverage  
5 variable having allowable values.

1       38. The method according to claim 37, wherein said  
2 abstract test suite references said coverage variable,  
3 and said step of generating is performed until said cov-  
4 erage variable has assumed each of said allowable values.

1       39. The method according to claim 37, wherein said  
2 directive further comprises a model independent direc-  
3 tive.

1       40. The method according to claim 37, wherein said  
2 model dependent directive comprises a plurality of model  
3 dependent directives, and said coverage variable is  
4 tagged by a plurality of tags of said model dependent di-  
5 rectives.

1       41. The method according to claim 37, wherein said  
2 tag is a number-of-tests-per-value tag.

1       42. The method according to claim 37, wherein said  
2 model dependent directive is a mask-value directive.

1       43. The method according to claim 29, wherein said  
2 directive comprises a plurality of directives that are  
3 combined to define a directive expression, wherein said  
4 step of generating is performed until said directive ex-  
5 pression has a predetermined value.

1       44. The method according to claim 29, wherein said  
2 step of modeling is performed by retrieving said behav-  
3 ioral model from a model archive.

1       45. The method according to claim 29, wherein said  
2 step of associating is performed by retrieving said focus  
3 from a focus archive.

1       46. The method according to claim 29, further com-  
2 prising the steps of comparing state variables of foci of  
3 said focus archive with state variables of said behav-  
4 ioral model; and

5           responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1       47. A computer software product for testing computer  
2 software, comprising a computer-readable medium in which  
3 computer program instructions are stored, which instruc-  
4 tions, when read by a computer, cause the computer to  
5 perform the steps of:

6           associating a behavioral model of a software applica-  
7 tion with a focus, said focus having a reference to said  
8 behavioral model, and having at least one directive,  
9 wherein said behavioral model models a finite state ma-  
10 chine;

11          deriving an abstract test suite from said behavioral  
12 model and said focus, wherein said abstract test suite

13 complies with a test constraint that is encoded in said  
14 focus;

15 executing said abstract test suite in an execution  
16 engine.

1 48. The computer software product according to  
2 claim 47, wherein said step of executing said abstract  
3 test suite comprises the step of generating a test script  
4 from said abstract test suite; wherein said test script  
5 is executed in said execution engine.

1 49. The computer software product according to  
2 claim 47, wherein said step of producing said abstract  
3 test suite is performed with a testing interface.

1 50. The computer software product according to  
2 claim 49, wherein said testing interface comprises an ab-  
3 abstract-to-concrete translation table.

1 51. The computer software product according to  
2 claim 49, wherein said testing interface comprises a test  
3 driver, having an operator interface, and further com-  
4 prising the step of:

5 varying parameters of said test driver via said op-  
6 erator interface in accordance with requirements of said  
7 software application.

1       52. The computer software product according to  
2 claim 47, wherein said directive comprises a model inde-  
3 pendent directive.

1       53. The computer software product according to  
2 claim 29, wherein said directive comprises a model de-  
3 pendent directive, and a coverage variable of said behav-  
4 ioral model is tagged by a tag of said model dependent  
5 directive, said coverage variable having allowable val-  
6 ues.

1       54. The computer software product according to  
2 claim 53 wherein said coverage variable comprises a plu-  
3 rality of coverage variables, and said step of generating  
4 is performed until a cross product of said coverage vari-  
5 ables has assumed all possible values thereof.

1       55. The computer software product according to  
2 claim 53, wherein said coverage variable comprises a plu-  
3 rality of coverage variables, and said step of generating  
4 is performed until an orthogonal array of said coverage  
5 variables has assumed all possible values thereof.

1       56. The computer software product according to  
2 claim 53, wherein said abstract test suite references  
3 said coverage variable, and said step of generating is  
4 performed until said coverage variable has assumed each  
5 of said allowable values.

1       57. The computer software product according to  
2 claim 53, wherein said directive further comprises a  
3 model independent directive.

1       58. The computer software product according to  
2 claim 53, wherein said model dependent directive com-  
3 prises a plurality of model dependent directives, and  
4 said coverage variable is tagged by a plurality of tags  
5 of said model dependent directives.

1       59. The computer software product according to  
2 claim 37, wherein said tag is a number-of-tests-per-value  
3 tag.

1       60. The computer software product according to  
2 claim 37, wherein said model dependent directive is a  
3 mask-value directive.

1       61. The computer software product according to  
2 claim 47, wherein said directive comprises a plurality of  
3 directives that are combined to define a directive ex-  
4 pression, wherein said step of generating is performed  
5 until said directive expression has a predetermined  
6 value.

1       62. The computer software product according to  
2 claim 47, wherein said step of modeling is performed by  
3 retrieving said behavioral model from a model archive.

1       63. The computer software product according to  
2 claim 47, wherein said step of associating is performed  
3 by retrieving said focus from a focus archive.

1       64. The computer software product according to  
2 claim 63, further comprising the steps of comparing state  
3 variables of foci of said focus archive with state vari-  
4 ables of said behavioral model; and

5            responsive to comparisons resulting from said step of  
6 comparing revising selected ones of said foci.

1       65. A computer system for testing computer software,  
2 comprising:

3            a user interface for creating a behavioral model of a  
4 software application, said behavioral model representing  
5 a finite state machine, wherein said user interface cre-  
6 ates a focus, said focus having a reference to said be-  
7 havioral model, and having at least one directive;

8            a compiler, for converting said behavioral model into  
9 an intermediate encoding thereof;

10          a test generator, accepting said intermediate encod-  
11 ing and said focus as input, and producing an abstract  
12 test suite;

13       an execution engine for executing a test program of  
14    said abstract test suite.

1       66. The system according to claim 65, wherein said  
2    execution engine produces a suite execution trace.

1       67. The system according to claim 66, further com-  
2    prising an analyzer which reads said suite execution  
3    trace, wherein said execution engine accepts an output of  
4    said analyzer.

1       68. The system according to claim 65, further com-  
2    prising a visualizer for visualizing an output of said  
3    execution engine.

1       69. The system according to claim 65, wherein said  
2    execution engine further receives input from an applica-  
3    tion model interface that is created by said user inter-  
4    face.

1       70. The system according to claim 65, wherein said  
2    directive comprises a model independent directive.

1       71. The system according to claim 65, wherein said  
2    directive comprises a model dependent directive, and a  
3    coverage variable of said behavioral model is tagged by a  
4    tag of said model dependent directive, said coverage  
5    variable having allowable values.

1       72. The system according to claim 71, wherein said  
2 directive further comprises a model independent direc-  
3 tive.

1       73. The system according to claim 71, wherein said  
2 test program references said coverage variable, and said  
3 test generator operates until said coverage variable has  
4 assumed each of said allowable values.

1       74. The system according to claim 73, wherein said  
2 coverage variable comprises a plurality of coverage vari-  
3 ables, and said execution engine executes until a cross  
4 product of said coverage variables has assumed all possi-  
5 ble values thereof.

1       75. The system according to claim 73, wherein said  
2 coverage variable comprises a plurality of coverage vari-  
3 ables, and said execution engine executes until an or-  
4 thogonal array of said coverage variables has assumed all  
5 possible values thereof.

1       76. The system according to claim 71, wherein said  
2 model dependent directive comprises a plurality of model  
3 dependent directives, and said coverage variable is  
4 tagged by a plurality of tags of said model dependent di-  
5 rectives.

1       77. The system according to claim 71, wherein said  
2 tag is a number-of-tests-per-value tag.

1       78. The system according to claim 71, wherein said  
2 model dependent directive is a mask-value directive.

1       79. The system according to claim 65, wherein said  
2 directive comprises a plurality of directives that are  
3 combined to define a directive expression, wherein said  
4 execution engine executes until said directive expression  
5 has a predetermined value.

1       80. The system according to claim 65, further com-  
2 prising a model archive that is accessed by said user in-  
3 terface.

1       81. The system according to claim 65, further com-  
2 prising a focus archive that is accessed by said user in-  
3 terface.